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HAZARDS TO UNDERGROUND WORKERS FROM INFLAMMABLE SURFACE STRUCTURES NEAR MINE OPENINGS

BY

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HAZARDS TO UNDERGROUND WORKERS FROM INFLAMMABLE SURFACE STRUCTURES NEAR MINE OPENINGS [1]

By D. Harrington[2] and M. W. von Bernewitz[3]

PURPOSE OF THIS PUBLICATION

Sections 120 and 121 of Article XI, Fire Control, of a proposed Mine Safety Law in preparation, to be used as desired and when approved by any State, contains these provisions:

> After the adoption of these regulations, no mine operator shall erect any nonfireproof structure within 50 feet of any mine entrance or airway. Every operating mine having nonfireproof structures within 50 feet of any mine entrance or airway, except headframes necessary for hoisting, shall have such structures fireproofed or removed and replaced with fireproof structures within six months of the adoption of these regulations. Before reopening, mines idle at the time of the adoption of these regulations shall have all nonfireproof structures fireproofed, removed, or replaced with fireproof structures as required by the foregoing sentence.
>
> Upon receipt of the written statement of a mine operator that the fireproofing of existing structures is impracticable, the chief mining engineer (of the State commission) shall satisfy himself as to the accuracy of the statement. If he concurs that fireproofing is impracticable, and if at the same time he holds the opinion that adequate protection can be provided otherwise by such procedure, he shall have authority to issue a written permit for the substitution of fireproof door at or near portals of mine openings and collars of shafts. Such doors shall fit as nearly gas-tight as possible and shall be installed in such a way that the mouths of mine openings can be closed readily from outside of structures. The effectiveness of such permit may be made contingent upon the operator's continued compliance with any additional precautions which are necessary in the chief mining engineer's opinion to protect the lives of miners.

1 - The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from the U. S. Bureau of Mines Information Circular 6557."

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The reason for inclusion of precautions of this type in a mine safety law should be obvious, but to those who may not understand why, it is only necessary to mention the fact that many lives and much property have been lost when fires have been transmitted from surface structures to underground workings, and many present-day mines have conditions such that a fire in surface structures would be likely to result in loss of life and probably of property in the mine. As the efficacy of gunited timbers in shafts, concrete-lined shafts, timbers treated with zinc chloride, fire doors, escapeways, and reversible ventilation to restrict or stop fires should be well known, these precautions will be discussed briefly, if at all; this paper covers only the hazard of lighted inflammable surface material or structures transmitting fire or poisonous gases or both into mine openings, whether they be shafts, slopes, drifts, adits, or tunnels, at metal, nonmetal, and coal mines.

METAL MINES

Long Wooden Shed Connecting Surface Shops with Tunnel Mouth. - At a metal mine at a high altitude in Colorado, opened by a long tunnel, safety engineers of the United States Bureau of Mines noted a long shed extending from the tunnel mouth to the carpenter, machine, and electrical repair shops. The greatest hazard at this property appeared to be that of fire; if one started in the surface shops, smoke would be drawn through the connecting shed into the mine because the tunnel was the intake. On account of the layout of the workings the smoke probably would not reach the workers, yet it would be very likely to cut off escape. A second exit could have been arranged at fairly reasonable cost, as there were several connecting shafts. Numerous other precautions which could be made available at little or no expense, were lacking. This situation is by no means unusual, and it is almost a miracle that accidents from fires at mine openings are not of almost daily occurrence.

Drift Mouth Houses in a Log Building Burns. - A fire occurred in a prospect mine in a western State about 8:30 a.m., on January 17, 1931, and destroyed a surface building at the drift mouth, burned some timber in the drift mouth, and caused some caving at the mine opening.

There is only one opening, and this drift, which is 1,500 feet long, branches 440 feet from the surface, and another drift is driven 500 feet left of the main drift. The mouth of the drift was housed in by a log building which contained a compressor, a 220-volt generator, and a gasoline motor. Approximately 300 electric detonators were stored in this building. An 8-inch zinc-coated pipe extending to within 20 feet of the face was depended upon to provide natural ventilation. The other end of the pipe was connected to a 30-foot chimney outside of the mine. Compressed air provided most of the ventilation.

While three men were in the mine, reports like outside blasts were heard. The manager started to investigate and encountered thick smoke about 400 feet from the drift mouth. The men broke the ventilating pipe outby the junction

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of the two drifts and stuffed coats in it to prevent air circulation. They then retreated several hundred feet into the longer drift and by so doing saved their lives. The building burned down, and then the men were rescued by a crew from an adjoining mine. The cause of the fire was not determined definitely, but there is no question that much inflammable material was in the surface structures which were inflammable themselves and located too close to the mine entrance. Moreover, in this case there was but one exit and there was no one in attendance at the surface while the men were working in the mine.

Wooden Snowshed Transmits Fire to Adit Opening. - At a western metal mine a fire of undetermined origin started in the surface plant 10:15 a.m. one day in July, 1930, and extended into the mine. Five men inside were asphyxiated. The surface buildings consisted of a compressor house and a blacksmith shop about 25 feet from an adit opening; these buildings were connected with the mine by a wooden snowshed. A similar snowshed connected the sluice boxes with the surface structures. An explosives magazine was situated about 75 feet from the end of a dump. The mine is opened by three adits in a gravel hillside to recover gold. The top adit, which is the present mine, is driven level for about 1,128 feet. About 765 feet from the portal a dip slant, 90 feet long, connects with the middle adit, which was the supposed escapeway; however, as is frequently the case in mines, but especially in small mines, it was impassable at the time of the fire. The cook, wife of one of the deceased men, observed the fire and gave warning to two men working in the lower adit near its portal and they escaped. The surface structures burned quickly and soon the fire began to burn the timber in the adit. Two forest rangers with the two workers who escaped and two fishermen entered the top adit and extinguished the fire in the timber near the portal at about 12:45 p.m. One forest ranger placed a wet blanket around his head and entered the relatively thick smoke and explored the top adit; he found no one and returned, rather confused. After waiting until the smoke cleared, the rescue party entered the mine and found the five men together in the lower adit. They had been traveling with the smoke and had proceeded 550 feet before they were overcome. The fire clearly shows the desirability of providing fire doors at the entrance of mines where there is a chance that fire can communicate from the outside to the inside. This was another instance of fire starting in an inflammable surface structure near the opening of a small mine, where no one was in attendance at the surface structure while men were working in the mine. Supposedly there was a second exit, but as is very frequently the case, it was impassable. If these men had known how to barricade themselves they might have saved themselves.

What a Burning Headframe did. - In 1928, fire broke out in the surface timber yard of a metal mine and burned the old wooden headframe and at the same time ruined the new steel headframe which was almost completed. The fire was probably started by a carelessly thrown match or cigarette butt and spread rapidly; there was little time to warn men underground by telephone before the wires, which were in the main shaft, were burned out. Several sets of shaft timbers below the collar were charred, and it is probable that the shaft was saved from more or less complete destruction because the

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mine had a fan. By using the reversing feature, the direction of air flow in the shaft was changed from normal downcast to upcast shortly after the fire was discovered. In all probability this action not only saved the shaft from being gutted by flame, but also prevented the approximately 125 underground employees from being trapped by poisonous gases and smoke; the men escaped into an adjacent mine. This shaft had been provided with a fire door near the surface but for some reason the doors were not used, probably because they had not been kept in condition for use. There is no question that the lives of many, if not all of these underground workers were saved by two safety features, both very frequently lacking at mines and especially metal mines: (1) A mechanical fan so installed as to allow reversing direction of air flow, and (2) a second exit, whether that exit was through an adjoining property or (preferably) in the mine itself.

Head-House Fire Endangers Six Men Underground. - In November, 1928, a fire in the head house, which included the blacksmith shop and other surface equipment, as well as the gallows frame, soon was transmitted to the shaft timbers near the surface. Not long afterwards falling pieces of burning boards and timber ignited the shaft timbers lower in the mine. A surface worker in order to warn the six persons working underground heroically climbed down the ladderway, notified the foreman some hundred feet below, and then forced his way back up the shaft through the smoke. The foreman assembled the men and unable to go through the gases and smoke in the shaft, led the men to safety through some old workings whose existence were known to few, if any one other than the foreman. Here the heroic action of one man and the special knowledge of another very probably saved several lives.

COAL MINES

Burning Surface Buildings Ignite Slope Timbers. - Between 1:00 and 5:00 a.m. one day in October, 1930, a fire of unknown origin consumed the surface buildings at a coal mine in the middle west. The fire was transmitted to the slope, the only opening to the mine, and resulted in the death of three men and the subsequent death of one other man (not employed in mining) who aided in the attempted rescue of the three men trapped in the mine - two machine men and a hoistman. The operation was a small wagon mine owned cooperatively by 10 men and had a slope driven 550 feet on a pitch of 25° to intersect the coal bed with entries turned right and left near the foot of the slope. Ventilation was by a small motor-driven fan placed near the slope mouth; a wooden brattice divided the slope down to a point where an airway was driven to the left, the return being up the slope haulage way. The fire practically destroyed the brattice as well as the timber sets for about 30 feet inby the slope mouth, and the poisonous fumes killed the three men trapped because of the fact that the only opening to the mine was on fire. This is another recent case, this time at a coal mine, where a fire of unknown origin started in an inflammable surface building adjacent to a mine opening, and where no one was in attendance at the surface, the hoistman having gone into the mine, presumably to assist with the underground work.

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The small mine employing fewer than 10 men is usually allowed to do essentially nothing to safeguard workers, and only too frequently little or nothing is done by the small mine to insure safety. In some States the inspection force is given no jurisdiction over mines unless more than a certain minimum number such as 5, 6, or 10 persons are employed; few if any States have a sufficient number of inspectors to allow giving adequate attention to the safety of all of the mines, including the small ones, and in many instances when the inspector tries to enforce reasonably safety regulations, he is confronted with poverty pleas or allegations of favoritism for the large operator, and so forth.

Fan Forces Flame from a Burning Fan Housing into Air Shaft. - At a coal mine in a mid-western State fire was discovered at the air shaft about midnight one night in 1928. The main force fan was at this air shaft, and there was a reserve fan at the main shaft. That night the blades of the fan were heard striking against the sides of the casing, probably because of the overheating and burning out of bearings, with consequent throwing of the fan shafting out of line; flame soon was seen issuing from the fan house, which was constructed of inflammable material. The timbering in the air shaft burned out for a distance of about 40 feet from the surface and burning embers falling down the shaft ignited the timber and coal bed at the foot of the shaft so that the mine workings were filled with poisonous smoke and gases. Seals were built at the bottom of the two other shafts. Thirteen days later the debris at the foot of the shaft was cleaned out and work continued until the next night, when the fire rekindled; the shaft was again sealed. After 45 days the seals were opened and mine recovery started. This fire shows the hazard of not enclosing the fan and fan approach in a fireproof structure and indicates the desirability of lining shafts with fireproof material. Fortunately, nobody except the company was injured by this fire; the property loss was heavy, the cost being many times what a reasonably safe fan installation would have cost in the first place.

Another Fan Forces Flame into a Mine. - At another coal mine a wooden conduit on the surface leading from a fan at the outcrop of a lower bed to workings (58 feet apart vertically) in a higher coal bed, caught fire and the fire spread into the mine. The property is near the summit of a mountain 1,360 feet high, and the topography is rugged and irregular. A 44-inch force fan worked inside a frame building near the mouth of the air course of the lower mine, and a frame conduit, 6 by 6 by 115 feet, extended up the hillside to the mouth of the air course of mine 1, which was in the upper coal. On the night of the fire, five men were working in the upper mine, and at 11:50 p.m. the fan house was discovered to be on fire. Efforts to stop the fan were futile; it continued to blow and carry flames up the wooden conduit, which burned fiercely, and smoke was forced into the mine. Although the fan motor and belt eventually burned, the updraft continued to force smoke and flame into the air course, which was burned for a distance of 150 feet. The attempts at rescue and recovery were extremely difficult; they included hauling around the mountain and installing an electric fan; surveying in the darkness with the aid of lamps and driving a 27-foot manway from the coal outcrop to the face of an entry;

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ventilation of the workings; discovery and recovery of the bodies; hauling an electric pump up the mountain and erecting it; fighting the fire with water from another mine; and finally extinguishing the fire on the seventh day.

CONCLUSIONS

A few pertinent conclusions can be drawn from the foregoing examples of surface fires which transmitted fire or smoke to mine openings.

1. To cause heavy loss of life in a mine it is not necessary for a fire which starts on the surface to ignite the whole shaft, slope, drift, or adit; smoke drawn into the workings may be enough to asphyxiate everybody, or the fire may burn only a few sets of timber at the entrance and so produce large volumes of fumes which are drawn inside. Not only should openings to all mines be fireproof, at least for some distance from the surface, but there also should be a suitable fire door at the entrance of shaft, inclined, or adit, so placed that, if necessary, not only fire but also fumes of any kind can either be kept out of the mine or sealed and retained in the mine.

2. No inflammable structure should be allowed closer than within 50 feet of any opening of any mine, and no inflammable materials such as oil, gasoline, explosives, etc., should be stored or stand, even temporarily, within 50 feet of any mine opening, regardless of whether the surrounding structures are of fireproof material.

3. Covered passageways from change houses or other surface structures to shafts or drifts are desirable in a cold or snowy climate, but such sheds should be of fire-resistant material such as light steel and zinc-coated corrugated iron, or rough lumber well gunited, and even then there should be doors so placed that fire or other gases from the surface structure can be kept from going into the mine. Some mines have a drift at shallow depth connecting shafts with change houses so the underground men need not be exposed to surface temperatures.

4. Every mine should have at least two openings which would act as escapeways if fire should start at the collar or mouth of one of them. These possible ways of escape should be kept at all times so that men in ordinary physical condition can travel through them without undue exertion or delay. In other words, they should at all times be maintained as escapeways in fact as well as in name.

5. The surface entrance to shafts or drifts should be safeguarded in various ways; if timbered, they should be gunited, or the timber before being placed should be treated with a fire-retarding preservative, or steel sets should be installed as fire breaks, or some timber sets should be removed and the rock or ground gunited, if it will stand, or preferably concreting should be done; this fireproofing should extend into the mine at least 50 feet from the surface and, if feasible, much farther.

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6. If a mine has mechanical ventilation (and all mines, coal or metal, should have mechanical ventilation), it should be so arranged that the fan can be stopped easily or the air current quickly reversed if, after due consideration is given the existing conditions, it is decided to be the correct procedure to do either of these things.

7. Fire may be caused by carelessness, which includes the lack of safeguarding from ignitions by electricity, lighting, smoking, open fire, and by many unforeseen means. But provision should be made at every mine, large or small, to meet an outbreak of fire from any source.

8. Fire-fighting equipment and men who understand how to use it should be distributed so as to be available at suitable and strategic points on the surface. The equipment should include a water service of plugs, hose, nozzles, buckets, and barrels, fire extinguishers, and sand. Certain men should be trained in fire-fighting methods and given regular drill.

9. Surface fire hazards at or near mine openings should be kept constantly in mind and available precautions taken as soon as such dangers are realized. The small mine is likely to be the worst offender in allowing dangerous conditions to exist near mine openings, but the larger mines, especially metal mines, are by no means free of surface fire hazards.

The foregoing information has been compiled from reports submitted during a period of years by engineers of the United States Bureau of Mines.

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